NEW BEDFORD LEACHATE ANALYSIS

Predictions of leachate quantity and quality were generated for four nearshore confined disposal facilities (CDFs) and are reported in the following tables. The HELPQ (Hydrologic Evaluation of Leachate Production and Quality, Version 2) module (Schroeder and Aziz 1996) of ADDAMS (Automated Dredging and Disposal Alternatives Modeling System, Version 4) (Schroeder and Palermo 1995) generated the leachate flux predictions using contaminant partitioning, permeability, and settlement data. Contaminant partitioning data was obtained from Report 5: Evaluation of Leachate Quality (Myers and Brannon 1988). Permeability and settlement data were generated from consolidation modeling using the PSDDF (Primary Consolidation, Secondary Compression and Desiccation of Dredged Fill, Version 2) module (Stark 1996) of ADDAMS.

Sediment Characteristics

The dredged material is an organic clay (OH) with an average liquid limit (LL) of 94 and plasticity index (PI) of 62, approximately 23% fine sands and 77% fines. The specific gravity was 2.40 and the initial conductivity (salinity) was 14.7 mmhos. The initial concentrations of total PCB, lead, and copper were 1500 mg/kg, 2013 mg/kg, and 1730 mg/kg, respectively.

CDFs

CDF A is a nearshore confined disposal facility (CDF) having a surface area of 8 acres. The design consists of hydraulically placing 10 ft of material (post-disposal) above the existing foundation, allowing for sedimentation and self-weight consolidation during the disposal operation. The actual average thickness of material is likely to be several feet less due to slope of the bottom and slope of the inside dike face. Two additional feet of clean dredged material are placed on top of the contaminated material to serve as a temporary cap while the material undergoes consolidation. As such, it was assumed based on results of sedimentation testing and self-weight primary consolidation modeling without desiccation that the initial void ratio would average 3.5. The foundation was assumed to be a 5 ft thick layer of compressible material underlain by an incompressible sandy layer. The compressible foundation material was modeled to be identical to the contaminated dredged material. The compressible foundation would rapidly assume a permeability characteristic of the loading, approximately 1.9×10^{-7} cm/sec, and after capping the permeability would decrease to 1.4×10^{-7} cm/sec. The mean water table was assumed to be 3 ft above the foundation. Material was assumed to start desiccation 90 days after the end of disposal operations. Three years after disposal CDF A was assumed to be covered with a final cap consisting of 2 ft of vegetated soil underlain by a geosynthetic liner with 6 in. of bedding material.

SDMS DocID 75000031

CDFs B and C are identical to CDF A except for their surface areas. CDF B has a surface area of 7.2 acres while CDF C has a surface area of 8.4 acres. The foundation properties are assumed to be the same as described for CDF A. Also, the disposal and capping operations are the same as for CDF A.

CDF D is similar to CDFs A, B, and C, differing primarily in only a few of its dimensions. CDF D is a nearshore confined disposal facility (CDF) having a surface area of 19 acres. The design consists of hydraulically placing 17 ft of material (post-disposal) above the existing foundation, allowing for sedimentation and self-weight consolidation during the disposal operation. The actual average thickness of material is likely to be several feet less due to slope of the bottom. The temporary and final caps are identical to those for CDFs A, B, and C in design and scheduling. The foundation properties are assumed to be the same as described for CDF A, except that its permeability was lower due to the higher loading on it resulting from the placement of a thicker layer of dredged material. The compressible foundation would rapidly assume a permeability of approximately 1.4×10^{-7} cm/sec, and after capping the permeability would decrease to 0.86×10^{-7} cm/sec. The mean water table was assumed to be 5 ft above the foundation. Also, the disposal and capping operations are the same as for CDFs A, B, and C.

Modeling Assumptions

The consolidation data used in the PSDDF model were obtained from the model's default data base and selected based on the PI of the material. The appropriateness of the data was verified with data from the leachate permeameter tests report in Report 5 (Myers and Brannon 1988) and the geotechnical tests. Conservative parameters were selected for drainage and evaporation process descriptions.

The soil moisture retention properties used in the HELPQ model were selected to yield the same drainage of initial moisture as the predicted settlement from the PSDDF model. Specifically, the thickness and porosity were set to the initial conditions, and the field capacity was adjusted to yield the drainage from consolidation. The wilting point was then adjusted to yield appropriate unsaturated drainage properties.

The layer configuration used in the HELPQ model was selected to reflect the characteristics of the hydrologic processes. The 10-ft (17-ft for CDF D) dredged material layer was divided into three layers. The top layer was 10 inches thick and designed for accurately modeling runoff, evapotranspiration, and infiltration. The second layer was the rest of the dredged material above the mean low water level and assigned a permeability that resulted from a few years of consolidation in order to model the long-term unsaturated drainage of infiltrated water. The third layer (bottom) was that portion of material below the mean low water level (3 ft for CDFs A, B, and C; 5 ft for CDF D). The 5-ft thick compressible foundation layer was modeled as a liner due to its low permeability.

LEACHATE AND CONTAMINANT MASS FLUX
FOR NEARSHORE CDF A

Year	Leachate Flux			
	Leachate Volume ft^3/yr	Total PCBs Mass g/yr	Lead Mass g/yr	Copper Mass g/yr
1	160,600	1,038	80.0	68.8
2	160,700	1,039	80.1	68.9
3	165,400	1,069	82.4	70.8
4	101,000	653	50.3	43.3
5	81,100	525	40.5	34.8
6	68,500	443	34.2	29.4
7	65,400	423	32.6	28.0
8	61,700	399	30.7	26.4
9	58,100	376	29.0	24.9
10	54,700	354	27.3	23.4
11	42,400	274	21.1	18.2
12	6,300	40.9	3.2	2.7
13	5,500	35.6	2.7	2.4
14	4,800	30.8	2.4	2.0
16	3,900	25.4	2.0	1.7
18	3,600	22.9	1.8	1.5
20	3,200	20.8	1.6	1.3
25	2,700	17.3	1.3	1.1
30	2,100	13.4	1.0	0.9
35	2,100	13.4	1.0	0.9
40	2,200	14.2	1.1	0.9
50	2,100	13.4	1.0	0.9
60	2,100	13.4	1.0	0.9
80	2,100	13.4	1.0	0.9
100	2,000	13.0	1.0	0.8

LEACHATE AND CONTAMINANT MASS FLUX
FOR NEARSHORE CDF B

Year	Leachate Flux			
	Leachate Volume ft^3/yr	Total PCBs Mass g/yr	Lead Mass g/yr	Copper Mass g/yr
1	144,500	934	72.0	61.9
2	144,700	935	72.1	62.0
3	148,900	962	74.2	63.8
4	90,900	588	45.3	38.9
5	73,000	472	36.4	31.3
6	61,700	399	30.8	26.4
7	58,900	380	29.3	25.2
8	55,500	359	27.7	23.8
9	52,300	338	26.1	22.4
10	49,200	318	24.5	21.1
11	38,200	247	19.0	16.4
12	5,700	36.8	2.8	2.4
13	5,000	32.0	2.5	2.1
14	4,300	27.7	2.1	1.8
16	3,500	22.9	1.8	1.5
18	3,200	20.7	1.6	1.4
20	2,900	18.8	1.4	1.2
25	2,400	15.6	1.2	1.0
30	1,900	12.0	0.9	0.8
35	1,900	12.1	0.9	0.8
40	2,000	12.8	1.0	0.8
50	1,900	12.1	0.9	0.8
60	1,900	12.1	0.9	0.8
80	1,900	12.1	0.9	0.8
100	1,800	11.4	0.8	0.7

LEACHATE AND CONTAMINANT MASS FLUX
FOR NEARSHORE CDF C

Year	Leachate Flux			
	Leachate Volume ft^3/yr	Total PCBs Mass g/yr	Lead Mass g/yr	Copper Mass g/yr
1	168,600	1,090	84.0	72.2
2	168,800	1,091	84.1	72.3
3	173,600	1,123	86.6	74.4
4	106,000	685	52.9	45.4
5	85,200	551	42.5	36.5
6	72,000	465	35.9	30.8
7	68,700	444	34.2	29.4
8	64,700	419	32.3	27.7
9	61,000	395	30.4	26.2
10	57,400	371	28.6	24.6
11	44,500	288	22.2	19.1
12	6,600	42.9	3.3	2.8
13	5,800	37.4	2.9	2.5
14	5,000	32.3	2.5	2.1
16	4,100	26.7	2.1	1.8
18	3,700	24.1	1.9	1.6
20	3,400	21.9	1.7	1.4
25	2,800	18.1	1.4	1.2
30	2,200	14.0	1.1	0.9
35	2,200	14.1	1.1	0.9
40	2,300	14.9	1.2	1.0
50	2,200	14.1	1.1	0.9
60	2,200	14.1	1.1	0.9
80	2,200	14.1	1.1	0.9
100	2,100	13.5	1.1	0.9

LEACHATE AND CONTAMINANT MASS FLUX
FOR NEARSHORE CDF D

Year	Leachate Flux			
	Leachate Volume ft^3/yr	Total PCBs Mass g/yr	Lead Mass g/yr	Copper Mass g/yr
1	296,000	1,914	147	127
2	294,800	1,906	147	126
3	293,600	1,898	146	126
4	162,600	1,052	81.1	69.7
5	156,700	1,013	78.1	67.1
6	154,600	1,000	77.1	66.2
7	154,500	999	77.0	66.2
8	116,200	751	57.9	49.8
9	88,100	569	43.9	37.7
10	86,800	562	43.3	37.2
11	85,400	552	42.6	36.6
12	83,100	537	41.4	35.6
13	81,000	524	40.4	34.7
14	78,700	509	39.2	33.7
16	57,800	373	28.8	24.8
18	18,500	120	9.2	7.9
20	16,200	105	8.1	6.9
25	12,100	78.2	6.0	5.2
30	9,700	62.7	4.8	4.1
35	8,400	54.1	4.2	3.6
40	6,900	44.5	3.4	2.9
50	6,400	41.3	3.2	2.7
60	6,000	38.7	3.0	2.5
80	5,600	36.1	2.8	2.4
100	5,500	35.5	2.7	2.3

Comparison with 1989 Estimates

Flux estimates were presented in Averett et al. (1989) for the initial 30-year period after filling the CDFs. CDF Nos. 1, 1B, 3, and 12 were included in the evaluation. A revised estimate was prepared in 1993 for CDF Nos. 1, 1B, and 7. A comparison of the 1989 and 1993 results to the results for the upland capped scenario presented in this paper are provided below.

LEACHATE ANALYSIS COMPARISONS

Parameter	1989	1993	1997
CDF Surface Area, sq ft	2,400,000	1,500,000	1,800,000
In Situ Estuary Sediment Volume, cu yd	484,000	NA	450,000
Total Percolation through CDF Bottom, in., Years 1-30	23	NA	37
Total PCB Flux, kg, Years 1-30	190	40	37
Total Cu Flux, kg, Years 1-30	6	NA	2.4

Side by side comparisons are difficult because different criteria were used for the calculations and the data have been presented differently. The 1989 data were based on conservative estimates for CDF Nos. 1, 1B, 3, and 12. The 1997 results are sums of the areas, volumes, and fluxes of the four nearshore CDFs; the percolation is a weighted average per unit area of the four CDFs. The 1997 evaluation represents the 30-year period after disposal. It includes 3 years with a temporary cap and 27 years with the final cap, while the 1989 evaluation assumed final capping immediately after draining the ponded water, within the six months after disposal. This difference accounted contributed an additonal 18 inches of infiltration into the contaminated dredged material and an additional 17 inches of percolation during the first 30 years. Despite the larger percolation value in the 1997 evaluation the 1989 fluxes were greater by factors of 5.2 for PCBs and 2.5 for copper. The differences in surface area and volume provide an explanation for about a third of the difference. The rest of the difference is accounted by the earlier estimates using the maximum batch leachate concentration throughout the entire period, while the estimates presented in this paper accounted for changes in leachate concentration with time.

<u>References</u>

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